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PHOTO-CVD DEVICE
[Hikari CVD sochi]

Shigefumi Itsudo, et al.

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INVENTORS	(72):	Shigefumi Itsudo, et al.
APPLICANT	(71):	000231464
		Ulvac Inc.
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Claim

In a photo-CVD device in which are disposed a reaction chamber that houses the substrate, a gas introduction inlet for introducing reaction gas into said reaction chamber, an exhaust outlet and an exhaust means that discharges the introduced gas, a light source for causing a photochemical reaction in said reaction gas and forming a thin film on said substrate, a light source chamber that houses said light source, and a light-transmitting gas spray plate that has many small holes between said reaction chamber and said light source chamber, wherein a first gas stream is introduced through said gas introduction inlet approximately parallel to the surface of the substrate housed in the aforementioned reaction chamber, and a second gas stream is introduced through said light transmitting gas spray plate that has many small holes onto the surface of said substrate from a direction perpendicular to the surface so that the aforementioned first gas stream is held in a laminar flow state near the surface of said substrate, a photo-CVD device characterized in that the thickness of the blowout width of the aforementioned first gas introduction inlet is variable.

Detailed explanation of the invention

[0001]

Technical field of application

The present invention relates to a thin-film formation device used for the manufacture of semiconductors, liquid crystal displays, etc.

[0002]

Prior art

In recent years, there has been active development of photo-CVD devices that use light energy, break down a chemical compound gas such as silane or disilane, and form a thin film on a silicon wafer of glass substrate. Photo-CVD devices that use light are received a large amount of attention as a next-generation device manufacturing method, since the temperature of the processes can be lowered, and no degradation of the substrate of formed film produced by charged particles occurs. However, in such photo-CVD devices, the major problem is that reaction products foul the light-transmitting window or lamp surface and the amount of light is reduced. To handle such problems, preventing fouling of the light-transmitting window or lamp surface by partitioning the reaction chamber and the light source chamber with a porous plate and purging with an inert gas through said porous plate has been proposed, as shown in Japanese Kokai Patent Application No. Sho 60[1985]-209248, for example. However, because a diluting effect caused by the purge cause occurs when such a fouling prevention mechanism is used, the new problem that occurs is that a very large film thickness distribution occurs from the reaction gas introduction inlet toward the exhaust outlet.

[0003]

To handle the problems above, the present inventors have developed (invented) a photo-CVD device with which it is possible to obtain a relatively good film thickness distribution of ±5% by using an ultraviolet ray transmitting porous plate (gas spray plate) with which the hole distribution density is changed by location and by changing the gas blowout amount by location.

[0004]

Figure 6 is a cross section showing a photo-CVD device with the constitution above. (1) is a reaction chamber that houses a substrate (2) to be processed, and a reaction gas introduction system and an exhaust system are connected to introduction inlet (3) and exhaust outlet (4), respectively. Introduction inlet (3), as shown in Figure 7, is a slit-like shape wherein the thickness (a) of blowout opening (5) is 1 mm, and the length (width) (b) is 250 mm. In reaction chamber (1), a state (6) on which substrate (2) is mounted is furnished, and normally it is kept at a constant temperature with a heater (7), etc. Reaction chamber (1) is also connected with a light source chamber (9) by spray plate (8) made of quartz which has many small holes. Quartz gas spray plate (8) which has many small holes, as shown in Figure 8, is designed so that small holes (10) that have a uniform diameter are distributed at non-uniform density approximately over the entire surface and so that the blowout amount decreases from the upstream of the reaction gas to the downstream. At the same time, in light source chamber (9), a light source (11) that emits an appropriate wavelength for the photochemical reaction is furnished so that substrate (2) can be irradiated with light. An inert gas introduction system is also connected to introduction inlet (12).

[0005]

Reaction gas is introduced through blowout opening (5) of introduction inlet (3) from the reaction gas introduction system approximately parallel to the surface of substrate (2), breakdown or reaction is caused by light of the appropriate wavelength, and a thin film is deposited on said substrate (2). In this case, [the device] is constituted so that inert gas introduced through inert gas introduction inlet (12) is introduced to reaction chamber (1) through quartz spray plate (8) that has many small holes (10) opposing the surface of substrate (2), so that film adhesion on light source (11) can be prevented.

[0006]

Problems to be solved by the invention

By using the photo-CVD device constituted as described above, a satisfactory film thickness distribution of ±5% can be obtained over the entire area in a 6-inch substrate. However, in order to obtain such a satisfactory film thickness distribution, a reaction gas introduction inlet with a blowout width of more than a certain length relative to the substrate diameter is required. Figure 9 shows film width distribution perpendicular to flow when a film is formed using a gas introduction inlet having a blowout width that 1.1 time, 1.3 time and 1.6 time the substrate diameter with film formation using a 6-inch substrate. As seen in Figure 9, when the blowout width is smaller, film thickness drops severely at the sides of the substrate. On the other hand, it can be seen that as blowout width increases, the drop in film thickness at the sides is improved. This seems to be because the flow of reaction gas blown out from the blowout width is not uniform, and the blowout amount drops at the ends of blowout opening (5).

[0007]

Therefore, if one wants to use a photo-CVD device constituted as described above to deposit a uniform film on a large surface-area substrate, a gas introduction inlet having a blowout width a minimum 1.6 time that substrate diameter must be used. However, by so doing, from the standpoint of device production, the problem is that this leads to the device becoming larger and the reaction gas flow in the reaction chamber becoming larger, and so causes higher cost.

[0008]

The present invention solves the problems as described above and has the objective of providing a photo-CVD device compatible with large-diameter substrates that is compact and low cost.

[0009]

Means to solve the problems

To achieve the objective above, in a photo-CVD device in which are disposed a reaction chamber that houses the substrate to be processed, a gas introduction inlet for introducing reaction gas into said reaction chamber, an exhaust outlet and an exhaust means that discharge the introduced gas, a light source for causing a photochemical reaction in said reaction gas and forming a thin film on said substrate, a light source chamber that houses said light source, and a light-transmitting gas spray plate that has many small holes between said reaction chamber and said light source chamber, wherein a first gas stream is introduced through said gas introduction inlet approximately parallel to the surface of the substrate housed in the aforementioned reaction chamber, and a second gas stream is introduced through said light transmitting gas spray plate that has many small holes onto the surface of said substrate from a direction perpendicular to the surface so that the aforementioned first gas stream is held in a laminar flow state near the surface of said substrate, the photo-CVD device of the present invention is characterized in that the thickness of the blowout width of the aforementioned first gas introduction inlet is variable.

[0010]

Function

With the photo-CVD device of the present invention constituted as above, the thickness of the blowout width of the gas introduction inlet is changed by location and the density distribution of the reaction gas perpendicular to flow can be freely controlled, so nearly the same film thickness distribution as with a conventional photo-CVD device can be obtained by using a relatively small gas introduction inlet, specifically one around 1-1.3 time the substrate diameter.

[0011]

Application example

Next, an application example of the present invention will be explained along with figures. Figure 1 is a schematic cross section of a photo-CVD device compatible with large-diameter substrates showing an application example of the present invention. Figure 2 (a) and (b) are a schematic oblique view of a reaction gas introduction inlet used by this application example in which the thickness of the blowout width is changed by location and a front view of the blowout opening formed at the ends of said introduction inlet.

[0012]

In the figures, (21) is a reaction chamber made of aluminum that houses a 6-inch glass substrate (22), and a reaction gas introduction system and an exhaust system are connected to introduction inlet (23) and exhaust outlet (24), respectively. Blowout opening (25) formed at the end of reaction gas introduction inlet (23), as shown in Figures 2 (a) and (b), has a length that is 200 mm wide and is constituted divided approximately into 3 parts with the center part and two sides at a ratio of 1 to 2 to supply reaction gas. Inside of reaction chamber (21), a stage (26) on which is mounted 6-inch glass substrate (22) is furnished, and it is kept at 250ºC by an infrared lamp heater (27). The reaction chamber is also connected with light source chamber (29) through a spray plate (28) made of quartz that is 200 mm x 300 mm in size, 2 mm thick and has many small holes 0.6 mm in diameter. Quartz spray plate (28) is formed with the number of small holes (30) 0.6 mm in diameter changed to give a blowout amount which is 3 to 2 to 1 in the 3 areas upstream, midstream and downstream. In light source chamber (29), a large surface area low-pressure mercury lamp (31) that emits a wavelength appropriate for a photochemical reaction is furnished so that

glass substrate (22) can be irradiated with light with uniform illumination. An inert gas introduction system is also connected to introduction inlet (32).

[0013]

In the device constituted as described above, silane and mercury vapor were used for the reaction gas and argon gas for the inert gas, an amorphous silicon film was deposited on 6-inch size glass substrate (22), and film thickness distribution was measured. The results are shown in Figure 5. As is evident from the O symbol in the figure, it can be seen that satisfactory film thickness distribution within ±5% was obtained over the entire area in a direction perpendicular to the reaction gas flow. This is approximately consistent with the distribution when a conventional type of reaction gas introduction inlet having a blowout width 1.6 times or more the substrate diameter is used.

[0014]

With the application example above, a shape wherein a slit 200 mm wide is divided into 3 parts was used, but using such a shape is not necessarily required. As shown in Figures 3 (a) and (b), it could be a shape in which the thickness gradually increases from the center toward the ends, or as shown in Figures 4 (a) and (b), a shape wherein a certain area in the center part is closed and only the ends are open. That is, as long as the thickness of the blowout opening at the center part and the ends is adjusted so that distribution perpendicular to the flow of reaction gas can be made uniform using experiments, computer simulations, etc. [the shape] can be anything. Actually, when film formation experiments were performed using the gas introduction inlets in Figure 3 and Figure 4, it can be seen that approximately the same distribution as the application example above is obtained, as seen in Figure 5.

[0015]

With the present invention, as explained above, by changing the thickness of the blowout width of the gas introduction inlet by location, the film thickness distribution perpendicular to the reaction gas flow can be freely controlled, so a compact, low-cost photo-CVD device can be obtained.

Brief description of the figures

Figure 1 is a cross section of a photo-CVD device showing an application example of the present invention.

Figure 2 shows an application example of a reaction gas introduction inlet used for the photo-CVD device of the present invention. (a) is a schematic oblique view, and (b) is a front view of the blowout opening.

Figure 3 shows another application example of a reaction gas introduction inlet used for the photo-CVD device of the present invention. (a) is a schematic oblique view, and (b) is a front view of the blowout opening.

Figure 4 shows still another application example of a reaction gas introduction inlet used for the photo-CVD device of the present invention. (a) is a schematic oblique view, and (b) is a front view of the blowout opening.

Figure 5 is a characteristics diagram of film thickness distribution of the film formed relative to reaction gas flow achieved using the gas introduction inlets in Figures 2 to 4.

Figure 6 is a cross section of a photo-CVD device showing a conventional example.

Figure 7 is an oblique view of the reaction gas introduction inlet in Figure 6.

Figure 8 is a schematic view of the gas spray play in Figure 6.

Figure 9 is a film thickness distribution characteristics diagram obtained when the gas introduction inlet blowout width is changed in a conventional type photo-CVD device.

Explanation of symbols

21 Reaction chamber

22 Glass substrate

23 Reaction gas introduction inlet

24 Exhaust outlet

25 Blowout opening

26 Stage

27 Infrared lamp heater

28 Spray plate made of quartz

29 Light source chamber

30 Small hole

31 Low-pressure mercury lamp

32 Inert gas introduction inlet

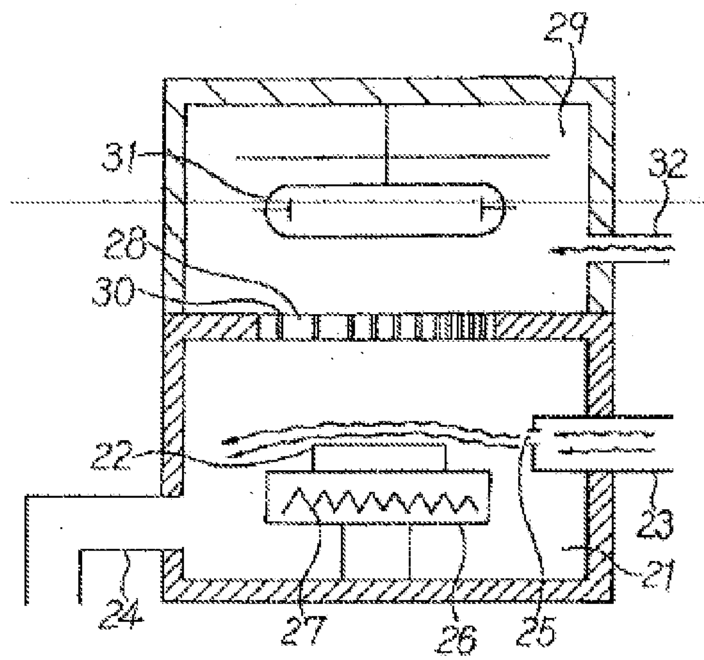


Figure 1

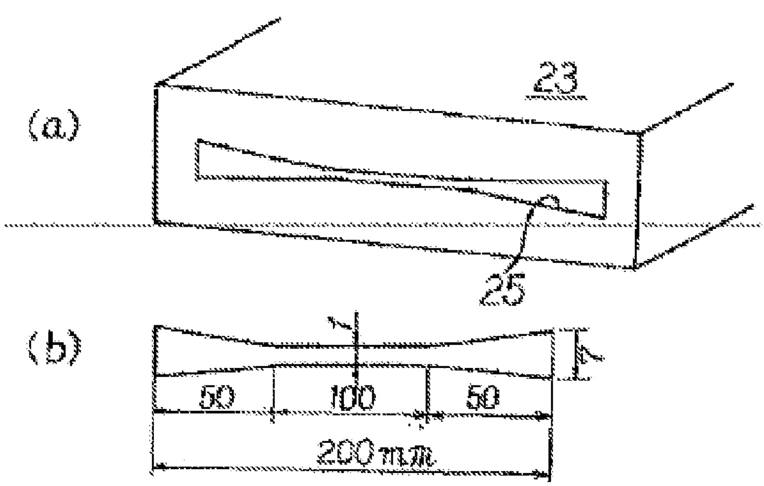
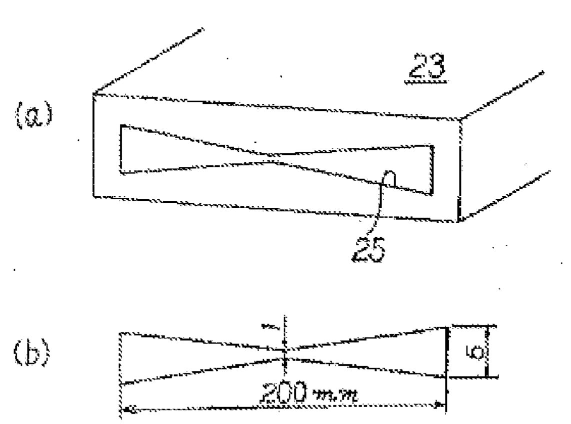


Figure 2



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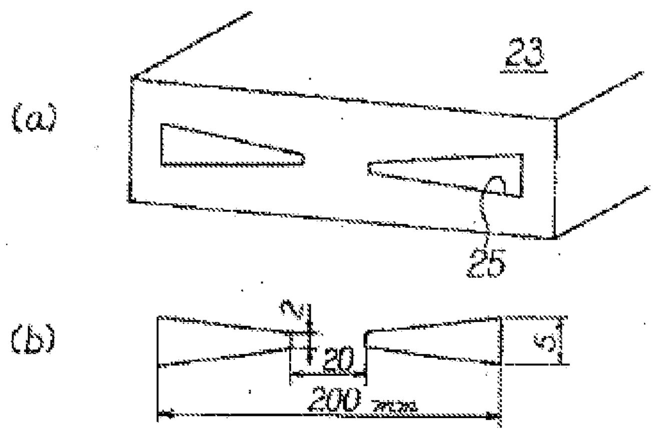

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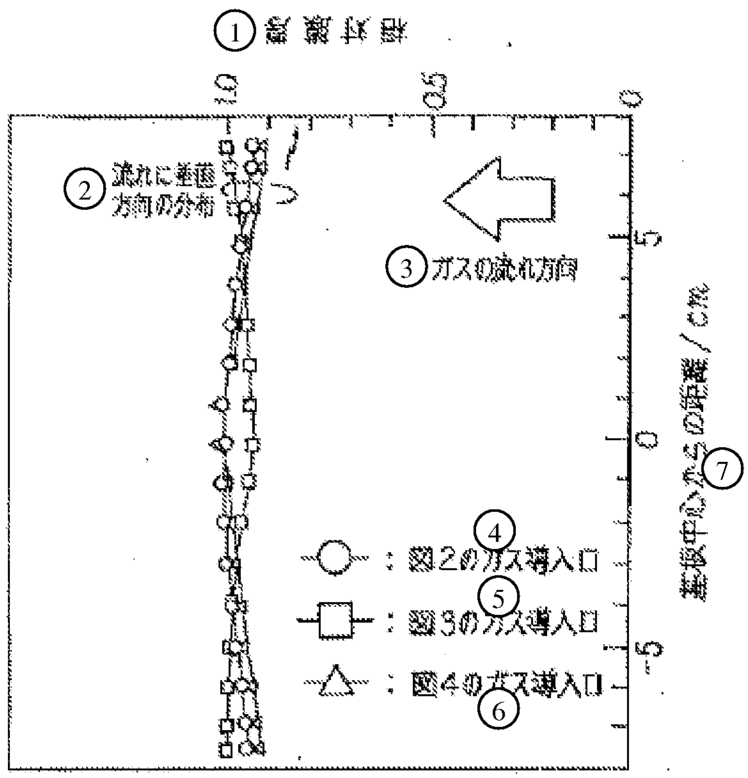

Figure 5

Key:

Key:	1	Relative film thickness
	2	Distribution perpendicular to flow
	3	Gas flow direction
	4	Gas introduction inlet in Figure 2
	5	Gas introduction inlet in Figure 3
	6	Gas introduction inlet in Figure 4
	7	Distance from substrate center

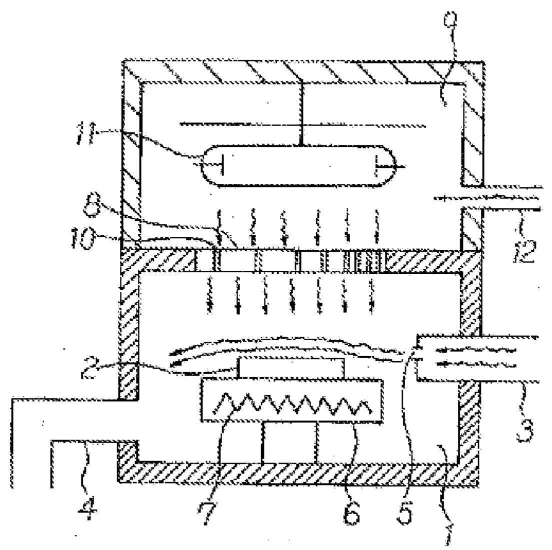

Figure 6

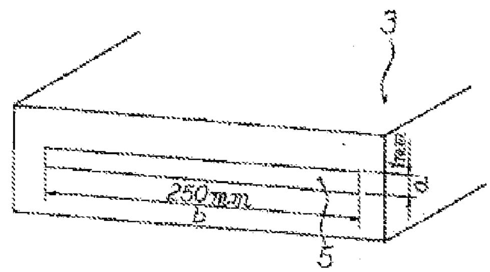

Figure 7

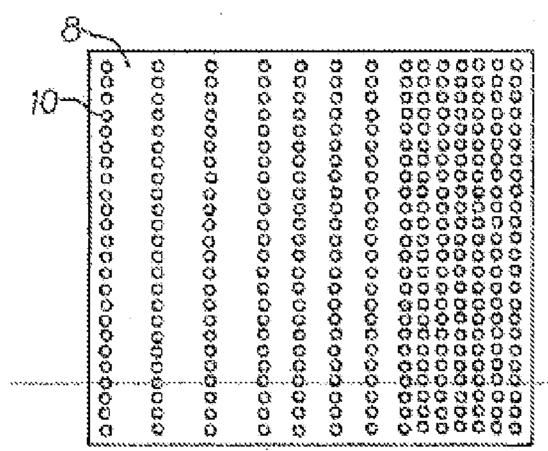

Figure 8

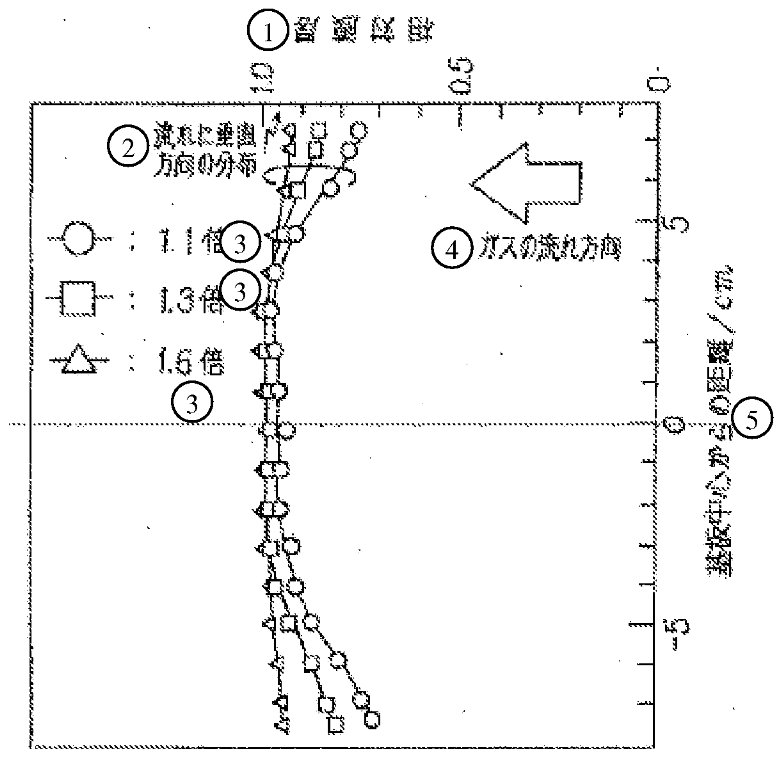

Figure 9

Key: 1 Relative film thickness

2 Distribution perpendicular to flow

3 ___ time

4 Gas flow direction

5 Distance from substrate center